

## Calibration results

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### Normalized Residuals

Reprojection error (cam0): mean 0.7343917761440568, median 0.7252103431557557, std: 0.30315274887713783  
Reprojection error (cam1): mean 0.9957594627054298, median 0.9975097737159101, std: 0.34221686869013485  
Reprojection error (cam2): mean 0.4909294297570128, median 0.45958634671532317, std: 0.2627286501220471  
Gyroscope error (imu0): mean 1.1859897319632562, median 0.950380232434768, std: 1.2003985759665106  
Accelerometer error (imu0): mean 1.241629530991039, median 1.1455835900542033, std: 0.6174134978142126

### Residuals

Reprojection error (cam0) [px]: mean 0.7343917761440568, median 0.7252103431557557, std: 0.30315274887713783  
Reprojection error (cam1) [px]: mean 0.9957594627054298, median 0.9975097737159101, std: 0.34221686869013485  
Reprojection error (cam2) [px]: mean 0.4909294297570128, median 0.45958634671532317, std: 0.2627286501220471  
Gyroscope error (imu0) [rad/s]: mean 0.0014489616072109331, median 0.001161109942132994, std: 0.0014665653530127171  
Accelerometer error (imu0) [m/s^2]: mean 0.03407031433039411, median 0.03143481371108734, std: 0.016941826380021993

### Transformation (cam0):

T\_ci: (imu0 to cam0):

```
[[-0.99999829 -0.00050051 -0.00178004 0.09476202]
[-0.00051623 0.99996078 0.0088411 0.01380209]
[0.00177554 0.008842 -0.99995933 -0.00947803]
[ 0.      0.      0.      1.      ]]
```

T\_ic: (cam0 to imu0):

```
[[-0.99999829 -0.00051623 0.00177554 0.09478581]
[-0.00050051 0.99996078 0.008842 -0.01367032]
[-0.00178004 0.0088411 -0.99995933 -0.00943099]
[ 0.      0.      0.      1.      ]]
```

timeshift cam0 to imu0: [s] (t\_imu = t\_cam + shift)  
0.009373867885262227

Transformation (cam1):

-----  
T\_ci: (imu0 to cam1):

```
[[[-0.99997408 -0.00013074 -0.00719893 -0.02530235]
[-0.00019542 0.99995963 0.00898384 0.01369063]
[ 0.00719746 0.00898502 -0.99993373 -0.00805069]
[ 0.      0.      0.      1.      ]]
```

T\_ic: (cam1 to imu0):

```
[[[-0.99997408 -0.00019542 0.00719746 -0.02524108]
[-0.00013074 0.99995963 0.00898502 -0.01362105]
[-0.00719893 0.00898384 -0.99993373 -0.00835531]
[ 0.      0.      0.      1.      ]]
```

timeshift cam1 to imu0: [s] (t\_imu = t\_cam + shift)  
0.009262547904497638

Transformation (cam2):

-----  
T\_ci: (imu0 to cam2):

```
[[[-0.99999808 0.0007019 0.00182869 0.0636933 ]
[ 0.00070912 0.99999193 0.00395339 0.01982619]
[-0.0018259 0.00395468 -0.99999051 -0.00565519]
[ 0.      0.      0.      1.      ]]
```

T\_ic: (cam2 to imu0):

```
[[[-0.99999808 0.00070912 -0.0018259 0.06366879]
[ 0.0007019 0.99999193 0.00395468 -0.01984837]
[ 0.00182869 0.00395339 -0.99999051 -0.00584999]
[ 0.      0.      0.      1.      ]]
```

timeshift cam2 to imu0: [s] (t\_imu = t\_cam + shift)  
0.009485665419609051

Baselines:

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Baseline (cam0 to cam1):

```
[[ 0.99998525 0.00032184 0.00542199 -0.12001603]
[-0.00032107 0.99999994 -0.00014218 -0.00008238]
[-0.00542203 0.00014044 0.99998529 0.00193906]
[ 0.      0.      0.      1.      ]]
```

baseline norm: 0.12003171938634694 [m]

Baseline (cam1 to cam2):

```
[[ 0.9999589 0.00091371 -0.00901972 0.08890949]
[-0.0008683 0.99998694 0.00503692 0.00615432]
[ 0.0090242 -0.00502888 0.99994664 0.00269226]
[ 0.      0.      0.      1.      ]]
```

baseline norm: 0.08916288880898014 [m]

Gravity vector in target coords: [m/s<sup>2</sup>]

[-0.01493133 -9.28421397 -3.15777944]

Calibration configuration

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cam0

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Camera model: pinhole

Focal length: [1060.3976965420115, 1059.9377777854759]

Principal point: [669.0410687042238, 338.0955078969839]

Distortion model: radtan

Distortion coefficients: [-0.39542241174697385, 0.1591019280356693, -0.00034525284843336024, 0.0009465391307443078]

Type: aprilgrid

Tags:

Rows: 5

Cols: 7  
Size: 0.04 [m]  
Spacing 0.01 [m]

cam1

-----  
Camera model: pinhole  
Focal length: [1055.696578079414, 1056.0327896352933]  
Principal point: [666.2914210045061, 331.25697121349526]  
Distortion model: radtan  
Distortion coefficients: [-0.39361678054112026, 0.15293568698596516, -0.0005106321308083494,  
0.001630476234212862]  
Type: aprilgrid  
Tags:  
Rows: 5  
Cols: 7  
Size: 0.04 [m]  
Spacing 0.01 [m]

cam2

-----  
Camera model: pinhole  
Focal length: [1268.4271589183275, 1267.7698267477979]  
Principal point: [644.7235579555121, 369.3053072152152]  
Distortion model: radtan  
Distortion coefficients: [-0.41736733429239814, 0.18973966738299014, -0.0001707595182044016,  
0.0006983044021555349]  
Type: aprilgrid  
Tags:  
Rows: 5  
Cols: 7  
Size: 0.04 [m]  
Spacing 0.01 [m]

IMU configuration

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IMU0:

-----

Model: calibrated

Update rate: 400.0

Accelerometer:

Noise density: 0.001372

Noise density (discrete): 0.02744

Random walk: 5e-05

Gyroscope:

Noise density: 6.10866e-05

Noise density (discrete): 0.0012217320000000001

Random walk: 4e-06

T\_ib (imu0 to imu0)

[[1. 0. 0. 0.]

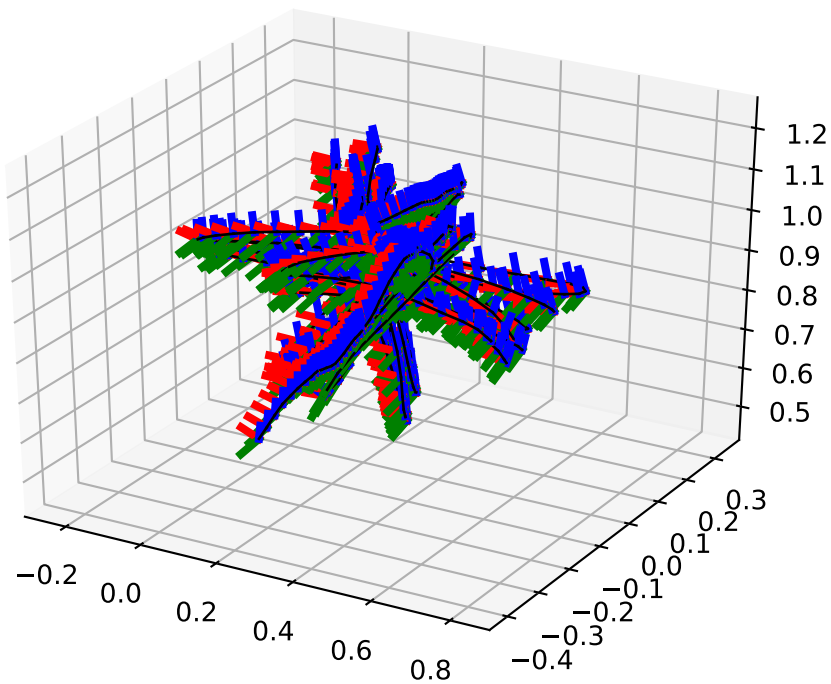
[0. 1. 0. 0.]

[0. 0. 1. 0.]

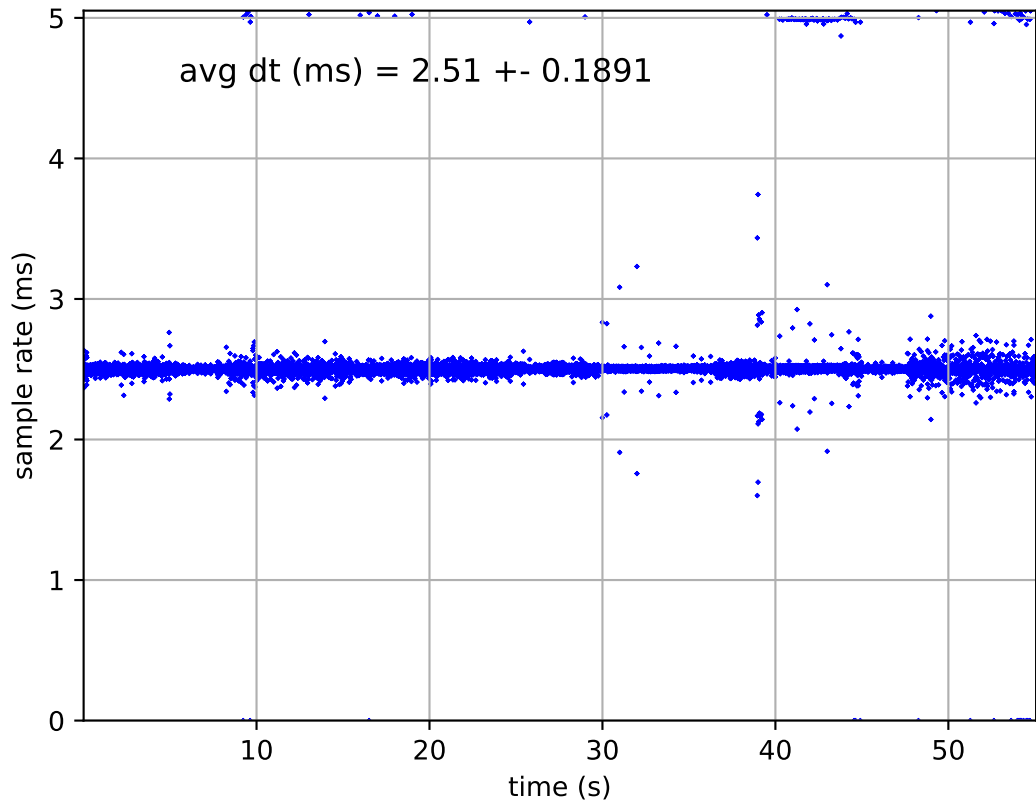
[0. 0. 0. 1.]]

time offset with respect to IMU0: 0.0 [s]

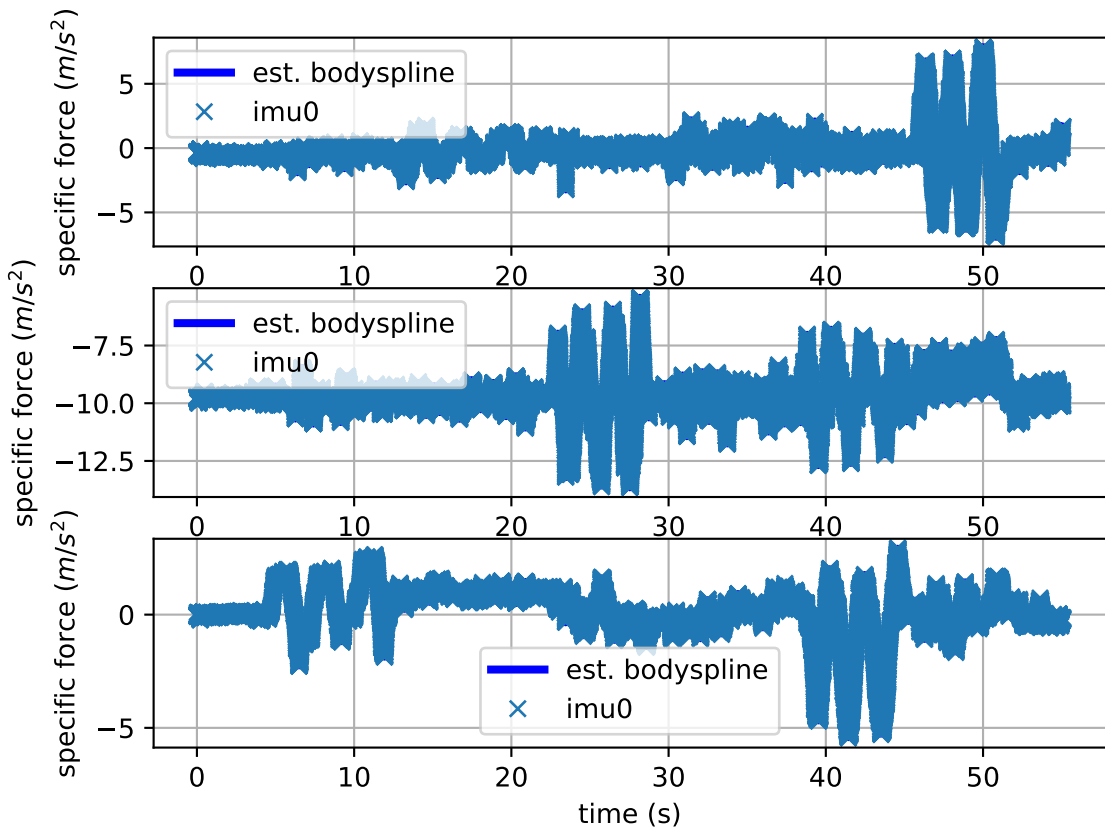
imu0: estimated poses



# imu0: sample inertial rate

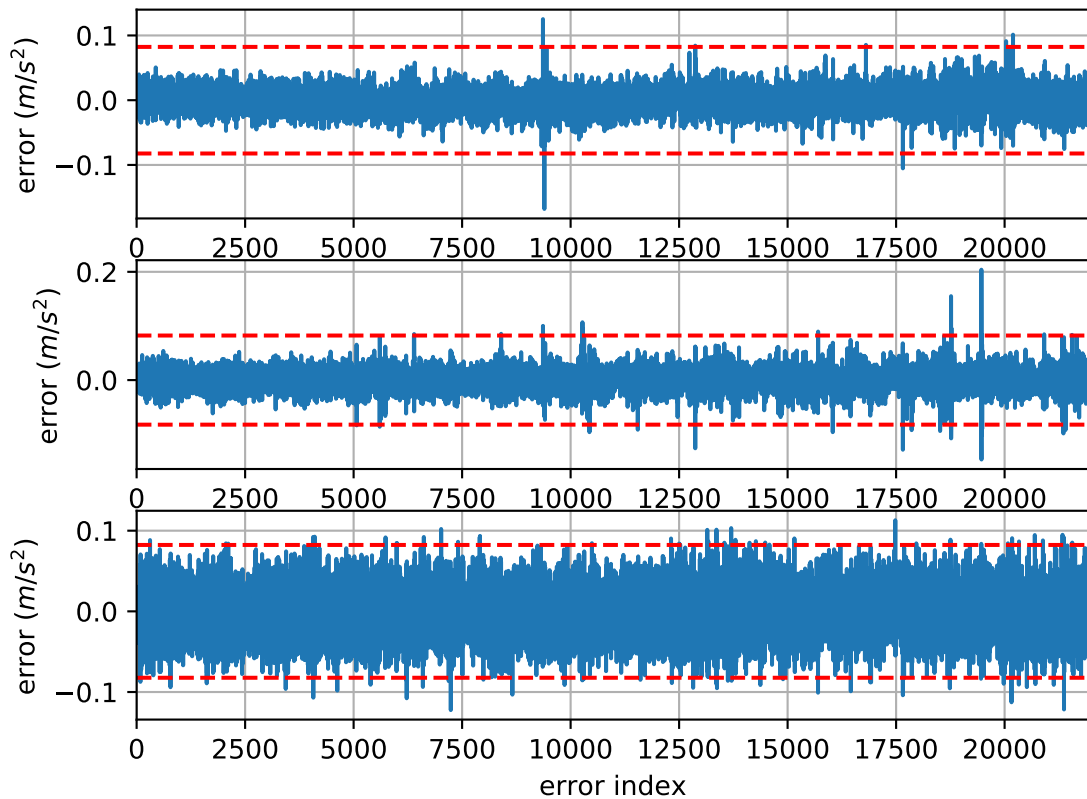


# Comparison of predicted and measured specific force (imu0 frame)

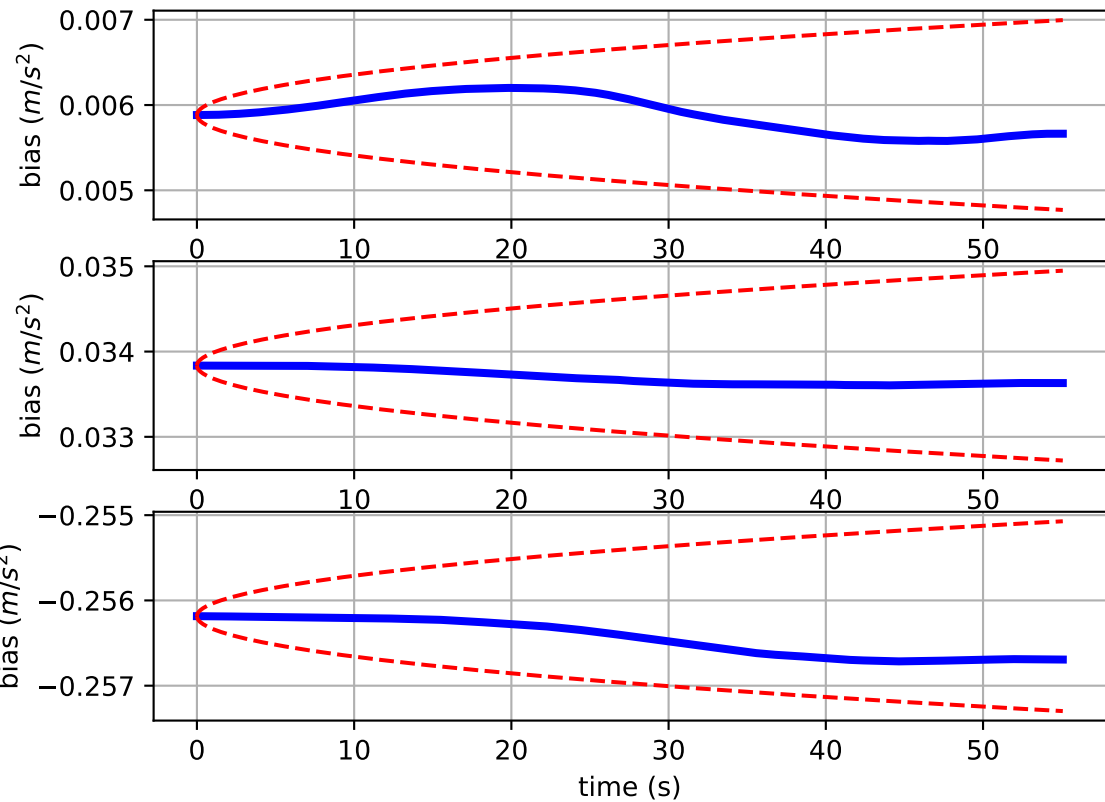




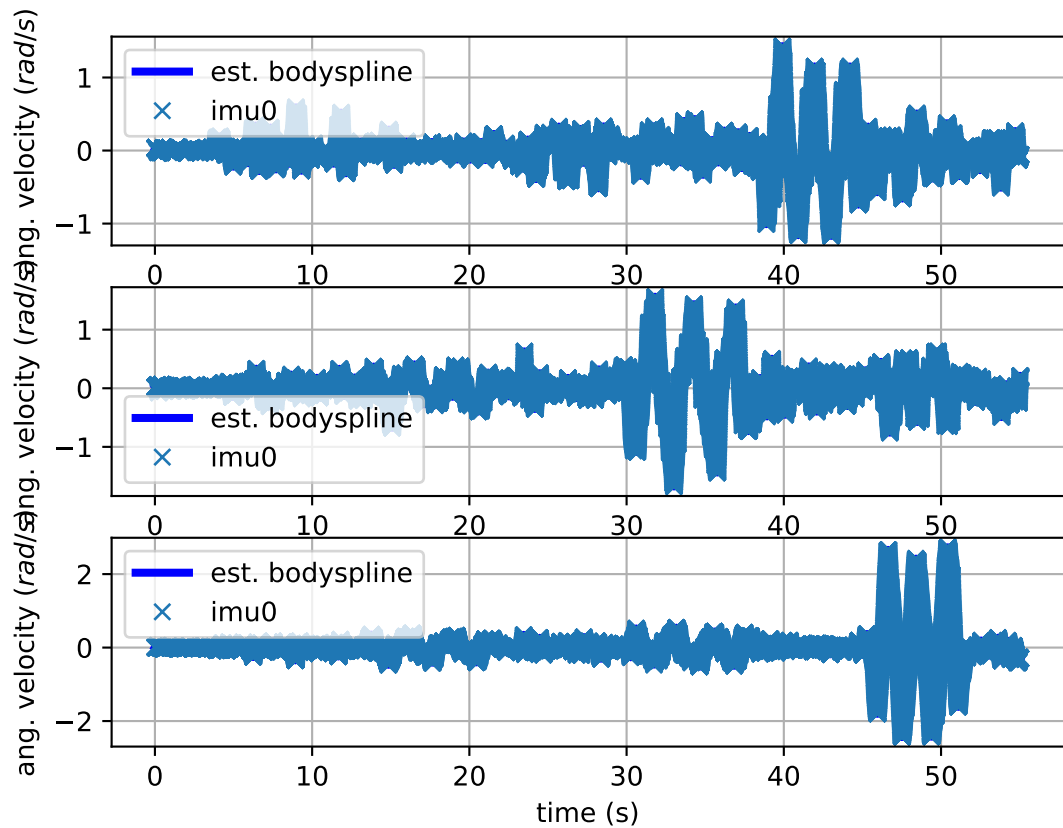
# imu0: acceleration error



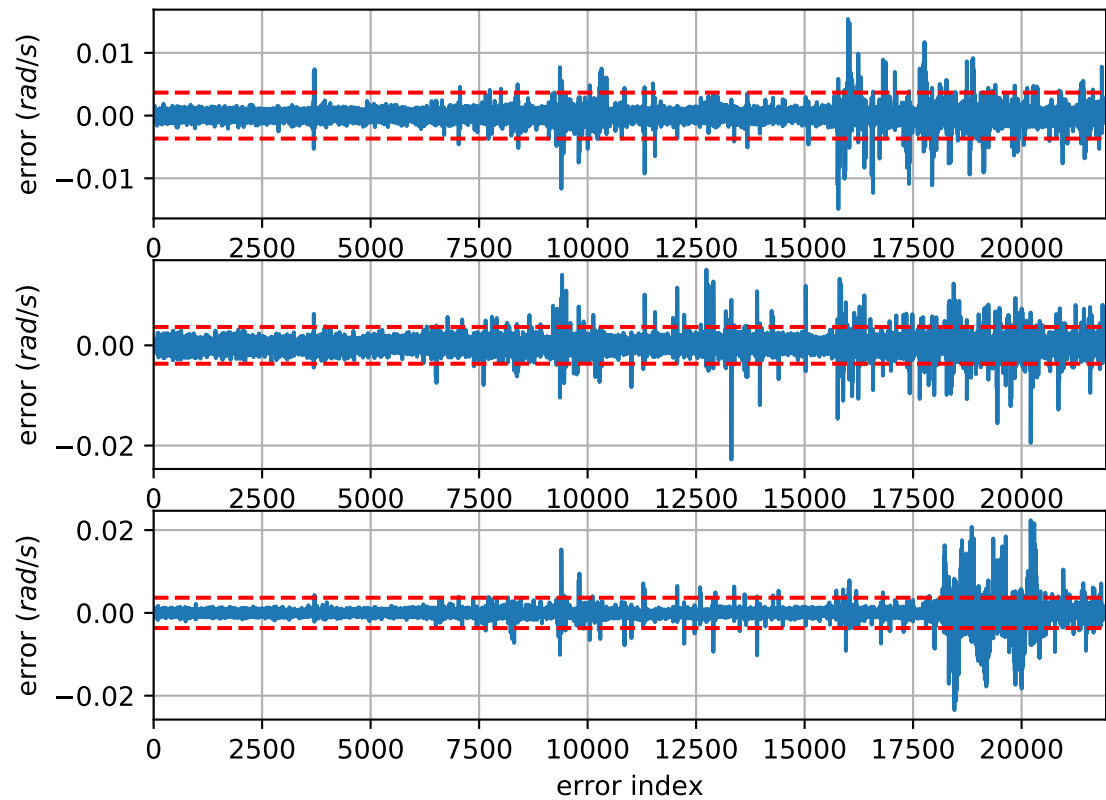
imu0: estimated accelerometer bias (imu frame)



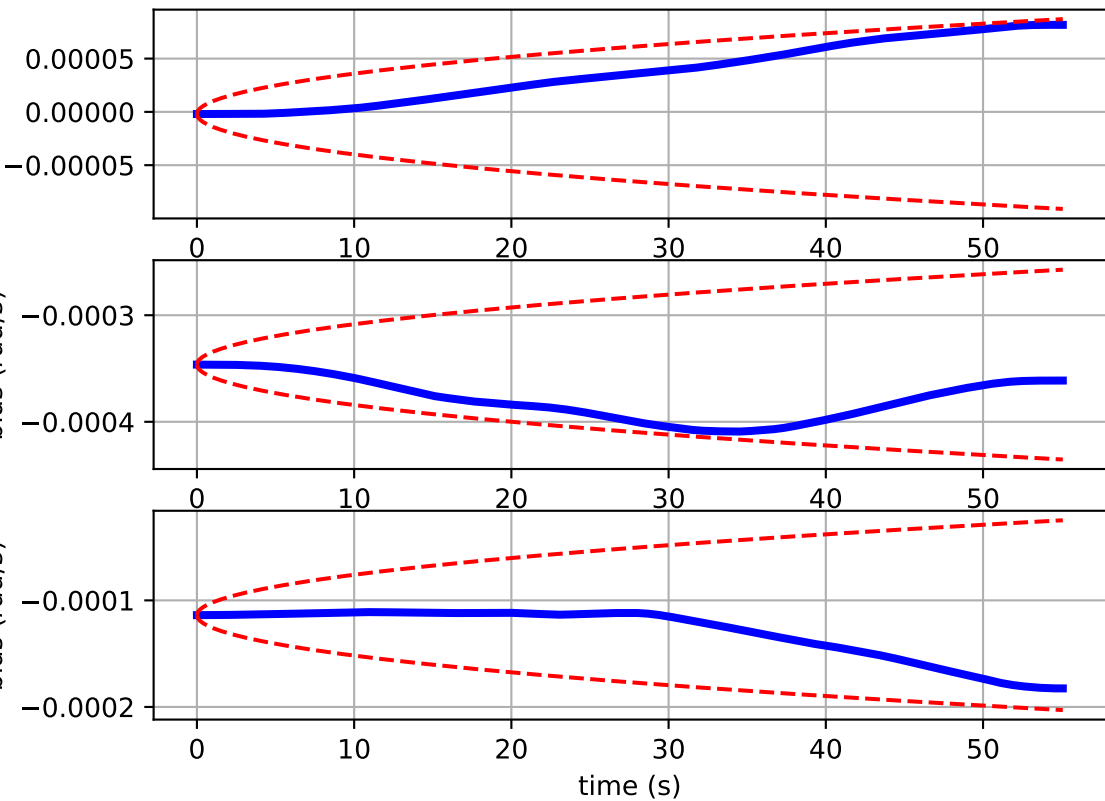
# Comparison of predicted and measured angular velocities (body frame)



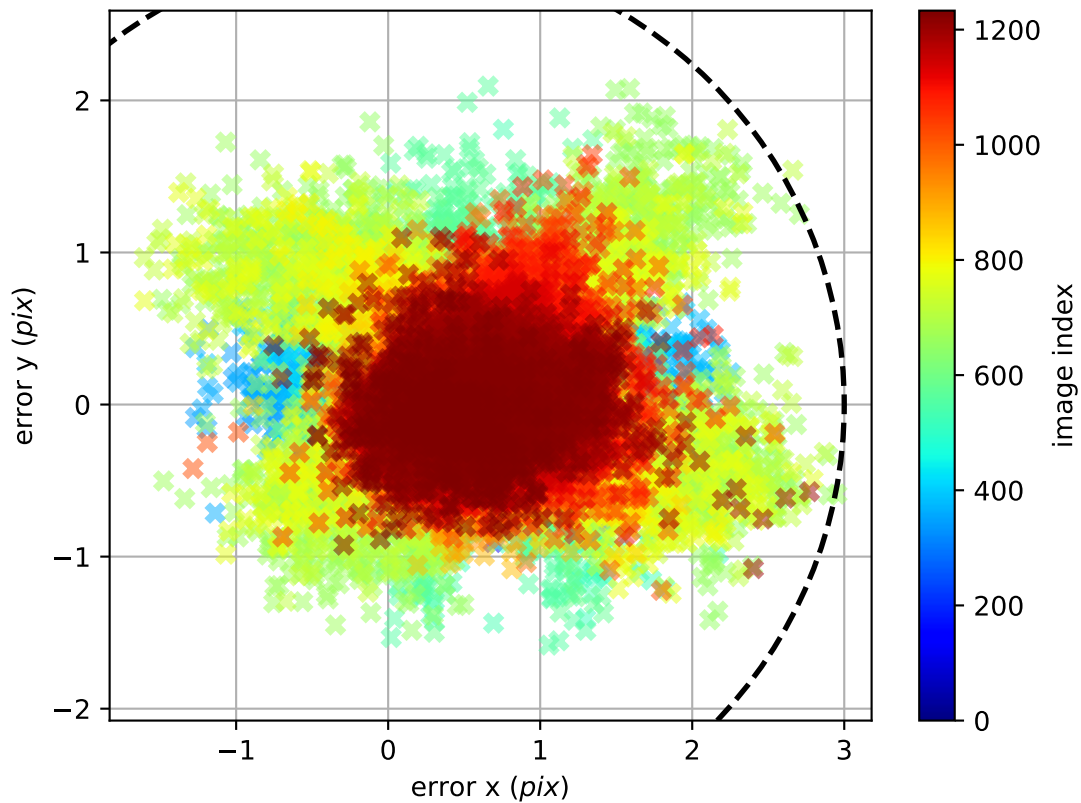
imu0: angular velocities error



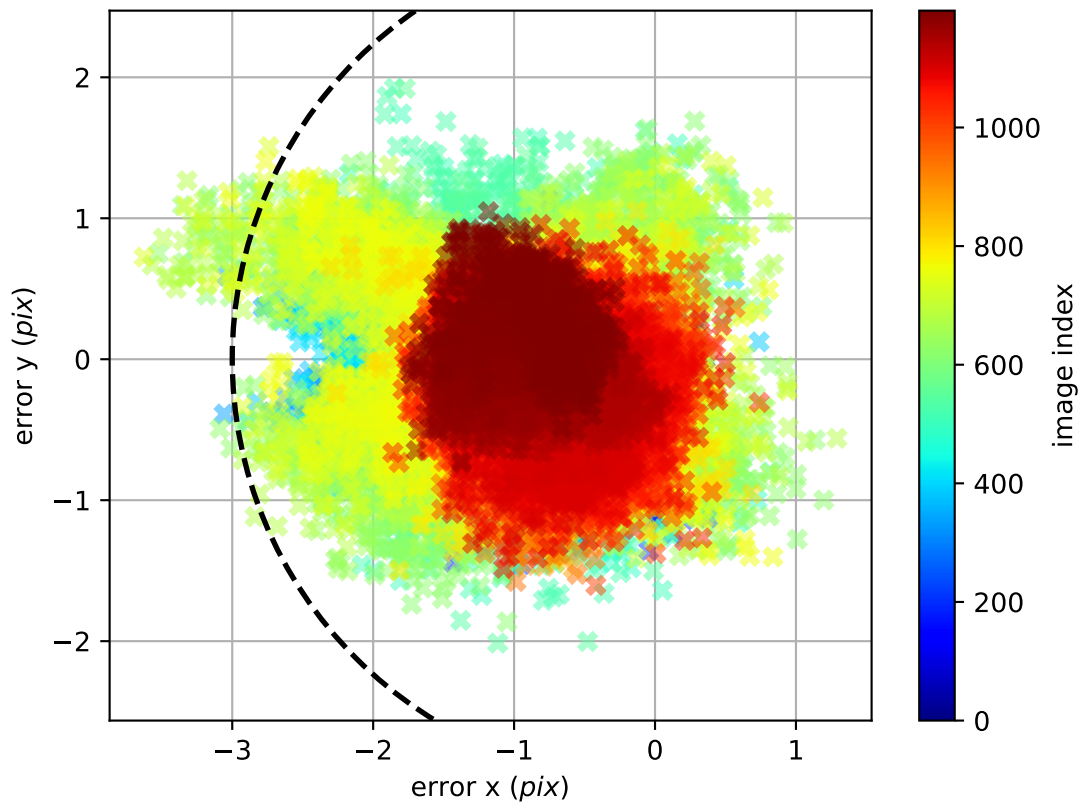
imu0: estimated gyro bias (imu frame)



cam0: reprojection errors



cam1: reprojection errors



cam2: reprojection errors

